

ABSTRACT OF THE DISCLOSURE

A tag flow measurement system wherein a first and a second measurement path are provided across a flowing fluid, and a receiver in each path receives signals modulated by scatters in the fluid. The direction of signal propagation in one path faces in an opposite sense to, e.g., is anti-parallel to, the direction of propagation in the other path, and the two receiver outputs are correlated to determine a time interval representative of flow velocity. In one embodiment each path is defined by a transmitter on one side of the conduit and a receiver on the other side of the conduit, and the positions or orientations of transmitter and receiver are reversed in the second pair. Thus, the first transmitter may lie on the same side of the conduit as the second receiver, and the second transmitter may lie on the same side of the conduit as the first receiver. Diametral or chordal paths may be used. A prototype clamp-on system detects flowing air at atmospheric pressure in a schedule 40 one inch steel pipe over an extended range, at flow rates as low as several meters per second. The coherent crosstalk between one transmitter and the receiver of the other pair is greatly reduced, and travels only through the pipe and not across the fluid, so the cross-correlation signal to noise ratio may be enhanced by a factor of ten or more over that of a conventional tag correlation system. This allows effective operation in small conduits, at small spacings, at low flows and in other difficult measurement situations. Each transmitter may operate at a different frequency, and the received signals may be demodulated in phase quadrature to further enhance channel separation and received signal power. Frequencies or frequency pairs in the range of approximately one to four megahertz may be useful for one inch pipe, while lower frequencies in the range of .1 to .5 megahertz are advantageously employed for larger conduits. Spacings may be 1/4 to 1/10 of a pipe diameter, and a common spacing, e.g., two inches may be employed for conduits over a diameter range of one to ten inches with high accuracy.